



# Standard Specification for Pressure-rated Polypropylene (PP) Piping Systems<sup>1</sup>

This standard is issued under the fixed designation F2389; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon ( $\epsilon$ ) indicates an editorial change since the last revision or reapproval.

<sup>ε1</sup> NOTE—9.1 was editorially corrected in July 2008.

## 1. Scope

1.1 This specification establishes requirements for polypropylene (PP) piping system components made to metric sizes and IPS schedule 80 sizes, and pressure rated for water service and distribution supply (see [Appendix X1](#)). Included are criteria for materials, workmanship, dimensions and tolerances, product tests, and marking for polypropylene (PP) piping system components such as pipe, fittings, valves, and manifolds.

1.2 The components governed by this specification shall be permitted for use in water service lines, hot-and-cold water distribution, hydronic heating, and irrigation systems.

1.3 The pipe and fittings produced under this specification shall be permitted to be used to transport industrial process fluids, effluents, slurries, municipal sewage, etc. The user shall consult the manufacturer to determine whether the material being transported is compatible with the polypropylene piping system and will not affect the service life beyond limits acceptable to the user.

1.4 *Units*—The values stated in inch-pound units are to be regarded as standard. The values given in parentheses are mathematical conversions to SI units that are provided for information only and are not considered standard.

1.5 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory requirements prior to use.*

## 2. Referenced Documents

### 2.1 ASTM Standards:<sup>2</sup>

<sup>1</sup> This specification is under the jurisdiction of ASTM Committee F17 on Plastic Piping Systems and is the direct responsibility of Subcommittee F17.61 on Water. Current edition approved Aug. 1, 2007. Published August 2007. Originally approved in 2004. Last previous edition approved in 2006 as F2389-06. DOI: 10.1520/F2389-07E01.

<sup>2</sup> For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

- D792 Test Methods for Density and Specific Gravity (Relative Density) of Plastics by Displacement
- D1505 Test Method for Density of Plastics by the Density-Gradient Technique
- D1598 Test Method for Time-to-Failure of Plastic Pipe Under Constant Internal Pressure
- D1600 Terminology for Abbreviated Terms Relating to Plastics
- D2122 Test Method for Determining Dimensions of Thermoplastic Pipe and Fittings
- D2749 Symbols for Dimensions of Plastic Pipe Fittings
- D3895 Test Method for Oxidative-Induction Time of Polyolefins by Differential Scanning Calorimetry
- D4101 Specification for Polypropylene Injection and Extrusion Materials
- F412 Terminology Relating to Plastic Piping Systems
- F2023 Test Method for Evaluating the Oxidative Resistance of Crosslinked Polyethylene (PEX) Tubing and Systems to Hot Chlorinated Water

### 2.2 International Organization for Standardization (ISO) Standards:

- ISO 3127 Thermoplastic Pipes—Determination of Resistance to External Blows—Round the Clock Method<sup>3</sup>
- ISO 4065 Thermoplastics Pipes—Universal Wall Thickness Table<sup>3</sup>
- ISO 9080 Plastics Piping and Ducting Systems—Determination of the Long-Term Hydrostatic Strength of Thermoplastics Materials in Pipe Form by Extrapolation<sup>3</sup>
- ISO 15874-2:2002 Plastics Piping Systems for Hot and Cold Water Installations—Polypropylene (PP)—Part 2: Pipes<sup>3</sup>
- ISO 15874-3:2002 Plastics Piping Systems for Hot and Cold Water Installations—Polypropylene (PP)—Part 3: Fittings<sup>3</sup>
- ISO/TS 15874-7 Plastics Piping Systems for Hot and Cold Water Installations—Polypropylene (PP)—Part 7: Guidance for the Assessment of Conformity<sup>3</sup>

### 2.3 NSF International Standards:

<sup>3</sup> Available from the International Organization for Standardization (ISO) 1, rue de Varembé, Case postale 56 CH-1211 Geneva 20, Switzerland.

**NSF/ANSI 14** Plastics Piping System Components and Related Materials<sup>4</sup>

**NSF/ANSI 61** Drinking Water System Components—Health Effects<sup>4</sup>

2.4 *European Norm:*

**prEN 10226-1** Pipe Threads Where Pressure Tight Joints are Made on the Threads—Part 1: Designation, Dimensions and Tolerances<sup>5</sup>

2.5 *American Society of Mechanical Engineers (ASME) Standard:*

**B1.20.1** Pipe Threads, General Purpose, Inch<sup>6</sup>

2.6 *Plastic Pipe Institute (PPI) Technical Report:*

**TR-4** PPI Listing of Hydrostatic Design Basis (HDB), Strength Design Basis (SDB), Pressure Design Basis (PDB) and Minimum Required Strength (MRS) Ratings for Thermoplastic Piping Materials<sup>7</sup>

### 3. Terminology

3.1 *Definitions:*

3.1.1 Definitions are in accordance with Terminology **F412** and abbreviations are in accordance with Terminology **D1600**, unless otherwise specified.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *polypropylene random copolymer (PP-R), n*—a polypropylene plastic containing not more than 50 % of another olefinic monomer (or monomers), having no functional group other than the olefinic group, copolymerized with the propylene.

3.2.1.1 *Discussion*—This term is also used for finished compound which comprises the PP-R resin and additives such as colorants, UV inhibitors, and stabilizers. Polypropylene random copolymers containing more than one additional monomer are often referred to as “terpolymers.”

3.2.2 *plastic-to-metal transition fittings, n*—a fitting designed to provide a means of connection between the PP piping system and metal piping systems such as steel pipe and copper tubing. The fittings include a means of taking into account the differences in thermal expansion of the materials and maintaining a pressure-tight seal over the intended use temperature range.

### 4. Classification

4.1 *General*—This specification covers PP piping systems made from PP materials (PP-R) in various dimension ratios and pressure ratings.

4.2 *Thermoplastic Pipe Series and Schedule*—This specification covers PP pipe made in schedule 80 IPS sizes and metric sizes in accordance with **ISO 4065**.

### 5. Materials and Manufacture

5.1 The pipe and fittings shall be polypropylene material of type PP-R. Clean rework material, of the same PP-R resin

<sup>4</sup> Available from the Deutsches Institut für Normung, Burggrafenstrasse 6, 10787 Berlin, Germany.

<sup>5</sup> Available from NSF International, 789 Dixboro Road, Ann Arbor, MI, 48105.

<sup>6</sup> European Committee for Standardization, 36, rue de Stassart, B-1050 Brussels.

<sup>7</sup> Available from the Plastics Pipe Institute, 1825 Connecticut Ave. N.W., Suite 630, Washington, DC 20009.

generated from the manufacturer’s own pipe or fitting production, shall be permitted to be used provided the pipe or fittings produced meet all requirements of this specification.

5.2 For pipe compound, the melt flow rate (MFR) shall not exceed 10.8 grain/10 min (0.7 g/10 min), when tested in accordance with D1238 using conditions of 4.76 lbm (2.16 kg) at 446°F (230°C).

5.3 The density of the unreinforced, natural color PP material shall not exceed 56.9 lbm/ft<sup>3</sup> (912 kg/m<sup>3</sup>), when tested in accordance with Test Method **D1505** or Test Method **D792**.

5.4 *Minimum Required Strength (MRS)*—The PP material used in the pipe and fittings shall have an MRS value of 1160 psi (8.0 MPa) or 1450 psi (10.0 MPa) based on testing in accordance with **ISO 9080** and classification of the lower confidence limit ( $\sigma_{LCL}$ ) at 50 years in accordance with ISO 12162.

5.5 *Categorized Required Strength (CRS<sub>0,t</sub>)*—The PP material used in the pipe and fittings shall have a CRS<sub>0,t</sub> value of 280 psi (1.93 MPa) based on testing in accordance with **ISO 9080** and classification of the lower confidence limit ( $\sigma_{LCL}$ ) at 180°F (82°C) and 50 years.

5.6 *Minimum Pressure Rating*—The minimum pressure rating of the pipe shall be 160 psi (1.1 MPa) at 73°F (23°C) and 100 psi (0.69 MPa) at 180°F (82°C) for hot-and-cold distribution and 160 psi (1.1 MPa) at 73°F (23°C) for cold water service.

5.7 *Threads*—Fittings shall be permitted to be threaded by use of metal inserts molded into the fitting.

5.7.1 Metal threads shall be constructed of brass or stainless steel inserts molded into the fitting.

5.7.2 Threads shall not be molded or fabricated directly into the polypropylene plastic.

5.8 The piping compound shall be permitted to include colorants, antioxidants, reinforcing materials and additives necessary for the finished product. The modified material and finished product shall meet all requirements of this specification.

NOTE 1—The Plastics Pipe Institute (PPI) publishes listings of minimum required strength (MRS) and categorized required strength (CRS<sub>0,t</sub>) ratings for thermoplastic piping materials in Technical Report No. 4 (**TR-4**). **ISO/TS 15874-7** provides guidance on evaluating the effect of additives on long-term strength of the pipe and fittings material.

### 6. Workmanship, Finish and Appearance

6.1 The pipe and fittings shall be free of visible cracks, holes, foreign inclusions, blisters and other known injurious defects. The pipe and fittings shall be uniform in color, opacity, density and other physical properties.

### 7. Dimensions and Tolerances

7.1 *Pipe Dimensions*—Pipe dimensions shall meet the requirements in 7.1.1 and 7.1.2.

7.1.1 *Outside Diameters*—The outside diameters and tolerances shall be as shown in **Table 1** (IPS Sch. 80), or **Tables 2 and 3** (metric series), when measured in accordance with Test Method **D2122**. For diameters not shown in these tables, the tolerance shall be the same percentage of outside diameter as those for the closest listed diameter.

**TABLE 1 IPS Schedule 80 OD and Wall Thickness**

Nominal Pipe Size	Average Outside Diameter, OD, in.		Tolerance on OD, in.		Out-of-roundness (max–min)		Minimum Wall Thickness, in.		Tolerance on Wall Thickness, in.	
1/2	0.840	(21.34)	±0.004	(±0.10)	0.015	(0.38)	0.147	(3.73)	+0.020	(+0.51)
3/4	1.050	(26.67)	±0.004	(±0.10)	0.020	(0.51)	0.154	(3.91)	+0.020	(+0.51)
1	1.315	(33.40)	±0.005	(±0.13)	0.025	(0.64)	0.179	(4.55)	+0.021	(+0.53)
1-1/2	1.900	(48.26)	±0.006	(±0.15)	0.030	(0.76)	0.200	(5.08)	+0.024	(+0.61)
2	2.375	(60.33)	±0.006	(±0.15)	0.035	(0.89)	0.218	(5.54)	+0.026	(+0.66)
3	3.500	(88.90)	±0.008	(±0.20)	0.040	(1.02)	0.300	(7.62)	+0.036	(+0.91)
4	4.500	(114.30)	±0.009	(±0.23)	0.050	(1.27)	0.337	(8.56)	+0.040	(+1.02)
6	6.625	(168.28)	±0.011	(±0.28)	0.050	(1.27)	0.432	(10.97)	+0.052	(+1.32)

**TABLE 2 Metric Sizes OD**

Nominal Size	Outside Diameter, OD					
	Minimum Average OD, in.		Maximum Average OD, in.		Maximum Out-of-roundness, in.	
16	0.630	(16.0)	0.642	(16.3)	0.016	(0.4)
20	0.787	(20.0)	0.799	(20.3)	0.016	(0.4)
25	0.984	(25.0)	0.996	(25.3)	0.016	(0.4)
32	1.260	(32.0)	1.272	(32.3)	0.020	(0.5)
40	1.575	(40.0)	1.591	(40.4)	0.020	(0.5)
50	1.969	(50.0)	1.988	(50.5)	0.024	(0.6)
63	2.480	(63.0)	2.504	(63.6)	0.024	(0.6)
75	2.953	(75.0)	2.980	(75.7)	0.039	(1.0)
90	3.543	(90.0)	3.579	(90.9)	0.039	(1.0)
110	4.331	(110.0)	4.370	(111.0)	0.039	(1.0)
125	4.921	(125.0)	4.969	(126.2)	0.051	(1.3)
140	5.512	(140.0)	5.563	(141.3)	0.063	(1.6)
160	6.299	(160.0)	6.358	(161.5)	0.063	(1.6)
200	7.874	(200.0)	7.953	(202.0)	0.079	(2.0)
250	9.842	(250.0)	9.941	(252.5)	0.098	(2.5)

**TABLE 3 Metric Sizes Wall Thickness**

Nominal Size	Minimum Wall Thickness															
	DR = 11		DR = 7.3		DR = 6		DR = 5									
	Min Wall, in.	Tolerance, in.	Min Wall, in.	Tolerance, in.	Min Wall, in.	Tolerance, in.	Min Wall, in.	Tolerance, in.	Min Wall, in.	Tolerance, in.	Min Wall, in.	Tolerance, in.				
16	0.071	(1.8)	+0.020	(+0.50)	0.087	(2.2)	+0.020	(+0.50)	0.106	(2.7)	+0.020	(+0.50)	0.130	(3.3)	+0.020	(+0.50)
20	0.075	(1.9)	+0.009	(+0.23)	0.110	(2.8)	+0.013	(+0.34)	0.134	(3.4)	+0.016	(+0.41)	0.161	(4.1)	+0.019	(+0.49)
25	0.091	(2.3)	+0.011	(+0.28)	0.138	(3.5)	+0.017	(+0.42)	0.165	(4.2)	+0.020	(+0.50)	0.201	(5.1)	+0.024	(+0.61)
32	0.114	(2.9)	+0.014	(+0.35)	0.173	(4.4)	+0.021	(+0.53)	0.213	(5.4)	+0.026	(+0.65)	0.256	(6.5)	+0.031	(+0.78)
40	0.146	(3.7)	+0.017	(+0.44)	0.217	(5.5)	+0.026	(+0.66)	0.264	(6.7)	+0.032	(+0.80)	0.319	(8.1)	+0.038	(+0.97)
50	0.181	(4.6)	+0.022	(+0.55)	0.272	(6.9)	+0.033	(+0.83)	0.327	(8.3)	+0.039	(+1.00)	0.398	(10.1)	+0.048	(+1.21)
63	0.228	(5.8)	+0.027	(+0.70)	0.339	(8.6)	+0.041	(+1.03)	0.413	(10.5)	+0.050	(+1.26)	0.500	(12.7)	+0.060	(+1.52)
75	0.268	(6.8)	+0.032	(+0.82)	0.406	(10.3)	+0.049	(+1.24)	0.492	(12.5)	+0.059	(+1.50)	0.594	(15.1)	+0.071	(+1.81)
90	0.323	(8.2)	+0.039	(+0.98)	0.484	(12.3)	+0.058	(+1.48)	0.591	(15.0)	+0.071	(+1.80)	0.713	(18.1)	+0.086	(+2.17)
110	0.394	(10.0)	+0.047	(+1.20)	0.594	(15.1)	+0.071	(+1.81)	0.720	(18.3)	+0.086	(+2.20)	0.870	(22.1)	+0.104	(+2.65)
125	0.449	(11.4)	+0.054	(+1.37)	0.673	(17.1)	+0.081	(+2.05)	0.819	(20.8)	+0.098	(+2.50)	0.988	(25.1)	+0.119	(+3.01)
140	0.500	(12.7)	+0.060	(+1.52)	0.756	(19.2)	+0.091	(+2.30)	0.917	(23.3)	+0.110	(+2.80)	1.106	(28.1)	+0.133	(+3.37)
160	0.575	(14.6)	+0.069	(+1.75)	0.862	(21.9)	+0.103	(+2.63)	1.047	(26.6)	+0.126	(+3.19)	1.264	(32.1)	+0.152	(+3.85)
200	0.716	(18.2)	+0.083	(+2.1)	1.079	(27.4)	+0.122	(+3.1)	1.311	(33.3)	+0.154	(+3.9)	1.575	(40.0)	+0.181	(+4.6)
250	0.894	(22.7)	+0.102	(+2.6)	1.346	(34.2)	+0.157	(+4.0)	1.642	(41.7)	+0.189	(+4.8)	1.968	(50.0)	+0.220	(+5.6)

7.1.2 *Wall Thicknesses*—The wall thicknesses and tolerances shall be as shown in **Table 1**, or **Tables 2 and 3**, when measured in accordance with Test Method **D2122**. For wall thicknesses (DR's) not shown in these tables, the minimum wall thickness shall be as calculated using the DR and outside diameter, and the tolerance on the wall thickness shall be the same percentage of the calculated minimum wall thickness as for the closest listed minimum wall thickness.

7.1.3 *Threaded Pipe*—Pipe covered by this specification shall not be threaded.

7.2 *Fittings Dimensions*—Fittings dimensions shall meet the requirements in **7.2.1** through **7.2.4**.

7.2.1 *Threads*—Taper threads for joining fittings shall comply with the requirements of ASME **B1.20.1** for NPT metal thread inserts or **prEN 10226-1** for metric threads. Threads used by the manufacturer to join component parts of a fitting together shall meet the manufacturer's specifications.

7.2.2 *Laying Lengths*—Laying lengths shall be in accordance with the manufacturer's specifications.

7.2.3 *Socket-fused Fittings*—Dimensions for socket-fused fittings shall be in accordance with **Tables 4 and 5** (IPS Sch 80) or **Tables 6 and 7** (metric series). Socket depth shall be measured from the face of the socket entrance to the face of the pipe stop at the socket bottom.

**TABLE 4 IPS Sch 80 Socket-weld Fittings**

Nominal Size	Socket Entrance, A					Socket Bottom, B						
	Average, in.		Tolerance on Average, in.		Maximum Out-of-roundness, in.	Average, in.		Tolerance on Average, in.		Maximum Out-of-roundness, in.		
1/2	0.840	(21.34)	±0.010	(±0.25)	0.012	(0.30)	0.794	(20.17)	±0.005	(±0.13)	0.012	(0.30)
3/4	1.050	(26.67)	±0.010	(±0.25)	0.012	(0.30)	1.000	(25.40)	±0.007	(±0.18)	0.012	(0.30)
1	1.311	(33.30)	±0.010	(±0.25)	0.016	(0.41)	1.258	(31.95)	±0.007	(±0.18)	0.012	(0.30)
1-1/2	1.898	(48.21)	±0.012	(±0.30)	0.016	(0.41)	1.830	(46.48)	±0.007	(±0.18)	0.015	(0.38)
2	2.383	(60.53)	±0.012	(±0.30)	0.016	(0.41)	2.308	(58.62)	±0.007	(±0.18)	0.015	(0.38)
3	3.513	(89.23)	±0.012	(±0.30)	0.040	(1.02)	3.427	(87.05)	±0.010	(±0.25)	0.020	(0.51)
4	4.522	(114.86)	±0.015	(±0.38)	0.040	(1.02)	4.417	(112.19)	±0.010	(±0.25)	0.020	(0.51)
6	6.656	(169.06)	±0.032	(±0.81)	0.050	(1.27)	6.512	(165.40)	±0.012	(±0.30)	0.040	(1.02)

**TABLE 5 IPS Sch 80 Socket-weld Fittings**

Nominal Size	Socket depth, C				Wall Thickness			
	Min, in.		Max, in.		Socket, E, Min, in.		Body, F, Min, in.	
1/2	0.835	(21.21)	0.865	(21.97)	0.147	(3.73)	0.185	(4.70)
3/4	0.960	(24.38)	0.990	(25.15)	0.154	(3.91)	0.195	(4.95)
1	1.085	(27.56)	1.115	(28.32)	0.179	(4.55)	0.225	(5.72)
1-1/2	1.335	(33.91)	1.365	(34.67)	0.200	(5.08)	0.250	(6.35)
2	1.460	(37.08)	1.490	(37.85)	0.218	(5.54)	0.275	(6.99)
3	1.830	(46.48)	1.860	(47.24)	0.300	(7.62)	0.375	(9.53)
4	2.205	(56.01)	2.235	(56.77)	0.337	(8.56)	0.420	(10.67)
6	2.955	(75.06)	2.985	(75.82)	0.432	#####	0.540	(13.72)

**TABLE 6 Metric Series Socket-weld Fittings**

Nominal Size	Socket Entrance, A					Socket Bottom, B						
	Minimum Average Diameter, in.		Maximum Average Diameter, in.		Maximum Out-of-roundness, in.	Minimum Average Diameter, in.		Maximum Average Diameter, in.		Maximum Out-of-roundness, in.		
16	0.598	(15.20)	0.610	(15.50)	0.016	(0.40)	0.594	(15.10)	0.606	(15.40)	0.016	(0.40)
20	0.756	(19.20)	0.768	(19.50)	0.016	(0.40)	0.748	(19.00)	0.760	(19.30)	0.016	(0.40)
25	0.953	(24.20)	0.965	(24.50)	0.016	(0.40)	0.941	(23.90)	0.957	(24.30)	0.016	(0.40)
32	1.224	(31.10)	1.240	(31.50)	0.020	(0.50)	1.217	(30.90)	1.232	(31.30)	0.020	(0.50)
40	1.535	(39.00)	1.551	(39.40)	0.020	(0.50)	1.528	(38.80)	1.543	(39.20)	0.020	(0.50)
50	1.925	(48.90)	1.945	(49.40)	0.024	(0.60)	1.917	(48.70)	1.937	(49.20)	0.024	(0.60)
63	2.437	(61.90)	2.461	(62.50)	0.024	(0.60)	2.425	(61.60)	2.445	(62.10)	0.024	(0.60)
75	2.925	(74.30)	2.949	(74.90)	0.039	(1.00)	2.878	(73.10)	2.902	(73.70)	0.039	(1.00)
90	3.516	(89.30)	3.539	(89.90)	0.039	(1.00)	3.461	(87.90)	3.484	(88.50)	0.039	(1.00)
110	4.307	(109.40)	4.331	(110.00)	0.039	(1.00)	4.240	(107.70)	4.264	(108.30)	0.039	(1.00)
125	4.898	(124.40)	4.921	(125.00)	0.039	(1.00)	4.827	(122.60)	4.850	(123.20)	0.039	(1.00)

**TABLE 7 Metric Series Socket-weld Fittings**

Nominal Size	Socket Depth, C				Wall Thickness			
	Min, in.		Max, in.		Socket, E, Min, in.		Body, F, Min, in.	
16	0.524	(13.30)	0.622	(15.80)	0.121	(3.06)	0.161	(4.08)
20	0.571	(14.50)	0.669	(17.00)	0.145	(3.69)	0.194	(4.92)
25	0.630	(16.00)	0.728	(18.50)	0.167	(4.25)	0.223	(5.67)
32	0.713	(18.10)	0.811	(20.60)	0.212	(5.38)	0.282	(7.17)
40	0.807	(20.50)	0.906	(23.00)	0.256	(6.50)	0.341	(8.67)
50	0.925	(23.50)	1.024	(26.00)	0.335	(8.50)	0.446	(11.33)
63	1.079	(27.40)	1.177	(29.90)	0.413	(10.50)	0.551	(14.00)
75	1.181	(30.00)	1.319	(33.50)	0.492	(12.50)	0.656	(16.67)
90	1.299	(33.00)	1.496	(38.00)	0.591	(15.00)	0.787	(20.00)
110	1.457	(37.00)	1.732	(44.00)	0.723	(18.38)	0.965	(24.50)
125	1.575	(40.00)	1.850	(47.00)	0.822	(20.88)	1.096	(27.83)

7.2.4 *Electrofusion Fittings*—Dimensions for electrofusion fittings shall be in accordance with manufacturer’s specifications.

7.2.5 *Valves and Flanges*—Dimensions for valves and flanges shall be in accordance with the manufacturer’s specifications.

## 8. Requirements

8.1 *Longitudinal Reversion*—When tested in accordance with ISO 15874-2, at the conditions given in **Table 8**, the mean relative change in pipe length shall not exceed 2 %.

8.2 *Melt Flow Rate (MFR) of Pipe and Fittings*—When tested in accordance with D1238, the MFR of specimens taken